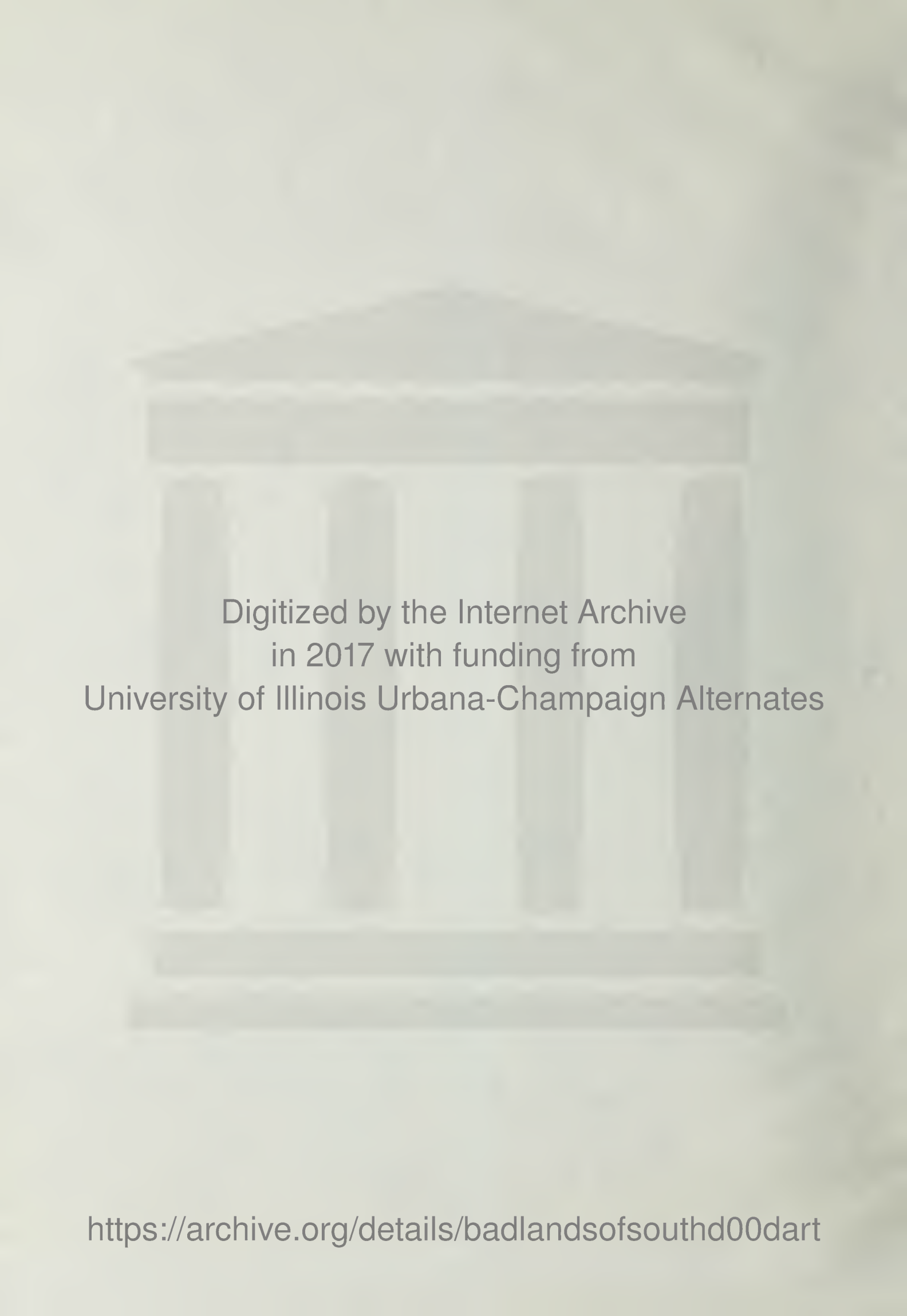

Geologische Charakterbilder

Begründet von **H. Stille**

Herausgegeben von

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o. Professor an der Universität Königsberg i. Pr.,
Direktor des Geologisch-paläontologischen Instituts und der Bernsteinsammlung der Albertus-Universität,
sowie der Hauptstation für Erdbebenforschung Königsberg-Gr. Raum

25. Heft

Badlands of South Dakota and Nebraska

by

N. H. DARTON, WASHINGTON

Inhalt des fünfundzwanzigsten Heftes

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Geologische Charakterbilder

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Die „Geologischen Charakterbilder" bringen Lichtdruckreproduktionen nach sorgfältigst ausgewählten photographischen Aufnahmen von geologisch und geographisch wichtigen und charakteristischen Bildungen, welche den Bau, die Entwicklung und die Oberflächengestaltung der Erdrinde zu veranschaulichen geeignet sind. Insbesondere werden Art und Wirkungen der endogenen und exogenen Kräfte, typische Entwicklungen der Gesteine und Formationen, die Struktur der Gebirge, sowie vor allem auch die Klein- und Großformen der Erdoberfläche in ihrem Zusammenhang mit der Entwicklung und dem Bau des Untergrundes zur Darstellung gelangen. Durchschnittlich sechs, gelegentlich mehr, gelegentlich weniger Bilder, die räumlich oder der Materie nach zusammengehörige Dinge darstellen, werden dabei zu je einem Hefte zusammengefaßt. Jedes Heft bildet eine selbständige Veröffentlichung des Autors und ist als solche auch einzeln käuflich.

Die „Geologischen Charakterbilder" sollen in erster Linie einem im geologischen und geographischen Unterrichte an Universitäten und anderen Hochschulen, sowie auch an höheren Schulen tief empfundenen Bedürfnisse nach bildlichem Demonstrationsmateriale abhelfen. Aber auch außerhalb von Hörsaal und Schule werden sie, da erst das Bild, erläutert durch das geschriebene Wort, eine lebendige Vorstellung der Dinge zu geben vermag, als wichtiges Hilfsmittel für wissenschaftliche Arbeit und literarische Tätigkeit auf geologischem und geographischem Gebiete willkommen sein. Schließlich können sie auch manchen Museen zur bildlichen Ausgestaltung ihrer naturwissenschaftlichen Sammlungen dienen, indem sie die Vorkommen einzelner ausgestellter Objekte in der Natur erläutern und erst dadurch dem Beschauer der Sammlungen die Bedingungen nahebringen, unter denen das Material gebildet oder gefunden wurde, was zur Abrundung seines Wissens unerläßlich erscheint — eine Ergänzung insbesondere der geologischen Sammlungen, welche aus dem toten Nebeneinander der Objekte einen lebensvollen Lehrstoff zu gestalten geeignet ist.

Für die Tafeln ist das Format 24:30 cm gewählt worden, da einerseits bei diesem eine scharfe Wiedergabe der im allgemeinen im Formate 9:12 cm aufgenommenen Originalbilder noch gewährleistet ist, während es anderseits als recht handlich für den praktischen Gebrauch in der Vorlesung usw. erscheint.

Jedem Bilde ist ein erläuternder Text beigegeben, so daß Wort und Bild sich zur Veranschaulichung der behandelten Materie ergänzen. Der erläuternde Text enthält, falls es wünschenswert erscheint, Skizzen und Profile, und die Bilder tragen erforderlichen Falles durchsichtige Deckblätter mit erläuternden Eintragungen.

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Der an eine Reihe der namhaftesten Geologen und Geographen gerichteten Bitte des Herausgebers um weitere Mitarbeit an dem Werke ist fast in allen Fällen eine freudige Zusage gefolgt, und so steht zu hoffen, daß die Sammlung bald ein mehr und mehr die ganze Erde umspannendes geologisch-geographisches Abbildungsmaterial umfassen wird. Geologen und Geographen, die geeignete Vorlagen besitzen und für weitere Kreise nutzbar machen möchten, sind zur Mitarbeit willkommen.

Fortsetzung s. S. 4 dieses Umschlags

Badlands of South Dakota and Nebraska

By N. H. DARTON, U. S. Geological Survey, Washington, D. C.

Badlands occur in various places in the arid and semiarid districts of the western portion of the United States, but the most extensive and striking tract now known is in the southwestern part of South Dakota a short distance east of the Black Hills. This area, known

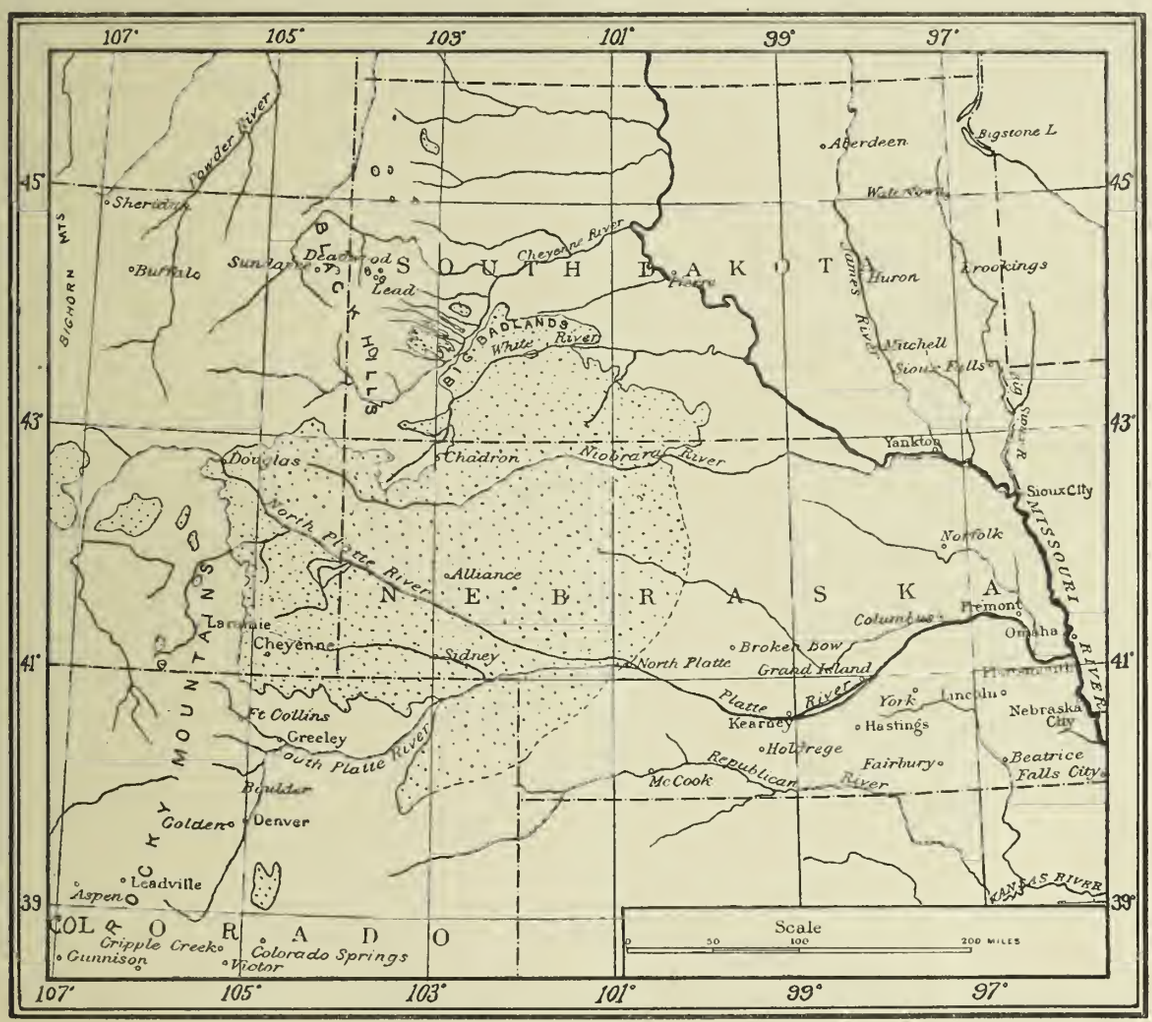

Fig. 1. Map of the north-central portion of the Great Plains of the United States showing the distribution of the Oligocene deposits and location of the Big Badlands.

as the Big Badlands, begins near Long. 101° and extends about 120 miles up White River nearly to the Nebraska line. Its width varies from 30 to 50 miles, and the total area is nearly 4000 square miles. The highest feature and most extensively dissected portion is in the ridge between White River and the South Fork of Cheyenne River. This tract was known many years ago to the French Canadian trappers, who gave it the name „Mauvaises Terres“, which signified, that it was a country difficult to travel through because of its extreme roughness and the scarcity of good water.

The Badlands of South Dakota and Nebraska are developed in the White River group, of the Great Plains representative of the Oligocene Epoch. This group underlies an area of about 18000 square miles, but originally its extent was considerably greater. Some features of its distribution are shown in figure 1.

To the southeast it slopes down under the later formations of the plains, which hide its limits; to the north it has been widely removed by erosion, but outliers cap prominent buttes for many miles; to the west it extends some distance up the slope of the Black Hills and Rocky Mountain Front Range, as shown in figure 2.

The White River group consists of Chadron-formation or Titanotherium-zone at base and Brule clay or Oreodon beds above. In the lower part of the Brule is the Metamynodon-sandstone, and higher up is another sandy member known as the Protoceras sandstone. The latter caps high plateau remnants in the middle of the Big Badlands, as shown in several of the views.

The materials of the White River group are mostly soft sandy clays, or partly lithified mixtures of fine sand and clay, fullers earth, volcanic ash and sandstone. The sandstone members are hard, coarse, cross-bedded rocks and in greater part represent old stream courses. At the base of the Chadron-formation are many old channels filled with pebble-and sand-deposits with local boulder beds. This formation lies unconformably on the Pierre-clay and in places on the lower member of the Fox Hills-sandstone. The total thickness of the White River group is about 500 feet. The views from some of the high points in the Badlands are farreaching and reveal a marvelous array of striking features. The vast areas of bare surfaces are dazzlingly bright in the sunshine. Mesas and buttes, pinnacles and spires of every form rise to varying heights in intricate succession. Small areas of the original plain remain as steep-walled outliers deeply notched by canyons and with projecting spires and pinnacles often of considerable altitude. The highest features in these Badlands rise from 150 to 300 feet above valleys, which extend far into the region and in places contain sufficient soil to sustain a sparse growth of grass. At intervals they contain water holes, in which limited supplies of rain water are occasionally preserved far into the summer, often covered by a thin pellicle of mud, which diminishes evaporation. One of the most prominent features of the Badlands is the „Great Wall", which extends for many miles along the north side of White River Valley. It is a bare escarpment descending steeply from a ridge of grass-covered old plain deeply invaded on the northwest by wide badland valleys extending to Cheyenne River.

Near the center of the Big Badlands rises a prominent remnant of the original plain, known as Sheep Mountain, named from the wild mountain sheep some of which still remain. Its table-like surface is covered with grass, but its slopes are marked by a wide zone of badlands consisting of high cliffs and long spurs deeply canyoned and broken into great butresses as shown in Tafel 2.

The principal factors in the development of badlands in this region is the massive structure of the moderately hard clay and soft silty sandstone, the steep declivity, by which erosion products are carried away and the arid climate which prevents growth of vegetation on the dry surfaces. The average annual rainfall is about 15 inches and the rains are mostly very heavy but of short duration. Originally the district was a relatively smooth plain, a product of late Oligocene deposition. It has been uplifted in recent geologic time, and White

River and the south fork of Cheyenne River have cut deep wide valleys into it, while their branch streams have worked back into ridges on either side. As erosion has progressed much of the surface has been sculptured into narrow ridges, steep-sided buttes, rounded domes, pinnacles, and castellated forms in endless variety. In places portions of the old plain cap the higher ridges as grass-covered tablelands or „mesas", mostly bounded by high rugged cliffs of hard sandy clay or soft silty sandstone, and deeply incised by intricately winding and many branching canyons. As erosion is more rapid than soil development the slopes are bare. The prevailing tints are flesh, cream, ashy, gray, pale green, and buff, which in some members are in alternating bands, bringing out the nearly horizontal attitude of the beds. Much of the material is finely homogeneous in texture, but variations in hardness of beds give rise to great variety of forms. Thin beds of harder sandstone cause cliffs, pinnacles and other irregularities in the slopes, and in places give great complexity to the configuration. The Titanotherium-beds consist largely of fullers earth of very pale green tint and this erodes in

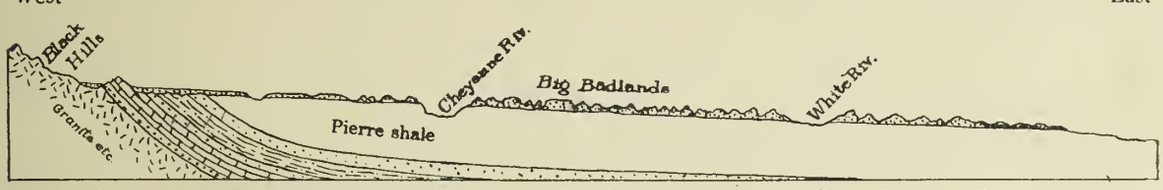

Fig. 2. Section from Black Hills eastward across the Big Badlands of western South Dakota. The dotted pattern is area underlain by Oligocene deposits (White River group).

rounded mounds covered with a blistered crust of mud left by the last rain storm. These lower beds are traversed by many thin, vertical veins of chalcedony (replacing selenite) which stand out in innumerable minute ridges and this hard material accumulates on the surface in fragmentary condition as the clay washes away. Numerous small vertical dikes of sandstone also cut the beds in places. The Badlands afford very instructive illustrations of erosion and therefore are of great interest to geologists.

For many years the Big Badlands of South Dakota were far off the ordinary lines of travel and there were but few roads. They were reached from Hermosa and other railroad points near the Black Hills and a camping trip of several days was required to visit them. Recently two lines of railroad have been built through the region and by this means they are much more easy of access. A large part of the area lies in the Pine Ridge Indian Reservation and the Badlands have played an important part in some of the Indian warfare.

Badlands are developed to greater or less extent throughout the outcrop zone of the White River group and very notable areas occur in western Nebraska especially near Scotts Bluff on the North Platte River, one feature of which is shown in Tafel 6.

The White River group contains many fossils, mostly mammalian, and the Big Badlands has long been a prolific collecting ground, visited frequently by parties seeking the animal remains. A large amount of fine material has been collected and is to be found in many museums in the United Staates and Europe. Among the many genera are: Titanotherium, Mericocidodon (Oreodon), Aceratherium, Symborodon, Colodon, Daphoenus, Cynodictus, Allops, Elotherium, Hyracodon, Hyaenodon, Dinictis, Metamynodon, Poebrotherium, Protoceras, Leptauchenia, Mesohippus, Testudo etc., etc.

Literature.

A few of the papers descriptive of the Big Badlands are given in the following list. There are many other papers relating to fossil bones and special features.

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Badlands of South Dakota and Nebraska

By N. H. DARTON-Washington.

Tafel 1.

‚Pulpit Rock' in Protoceras sandstone area, Big Badlands, western South Dakota.

This very remarkable erosion feature is in the center of the Big Badlands on a small valley near the head of Cottonwood Creek. Its name is derived from its resemblance to a form of church pulpit. The rock is about 40 feet high as shown by comparison with the man in middle ground. The material of the projecting ledge is hard, coarse, gray sandstone of the horizon which yields the bones of Protoceras in the immediate vicinity. A continuation of the same bed is seen in middle of view and in the right distance where it caps a small plateau. The sandstone is underlain by the typical material of the badlands, a mixture of pale buff fine sand and clay constituting a sandstone which is so soft that it is rapidly eroded. This feature has facilitated the undermining of the hard sandstone ledge, causing the projections and also developing pillars where the hard sandstone extends beyond the softer deposit. The survival of the harder rock is well illustrated on the plateau where the rock is in place and also in its accumulation on the talus. The region is one of semiarid climate; the badland features would not develop in a humid district where the soft materials would rapidly wash and flow into slopes which would soon be sod covered.

The geology of the region is described by N. H. DARTON, Geology of the Great Plains, U. S. Geol. Survey, Professional Paper No. 32.

Tafel 2.

Spur of south end of Sheep Mountain, Big Badlands, western South Dakota.

Sheep Mountain in the center of the Big Badlands is a large flat-topped remnant of the original high plain from which the Badlands were developed. It now stands about 300 feet above adjoining valleys and on all sides presents vertical walls and steep slopes eroded into infinite variety of badland forms. At its south end several large ridges project for some distance, one of which is shown in Tafel 2. It exhibits the nearly horizontal succession of sandy clays of the Brule formation, or Oreodon zone, capped by the harder, more sandy material of the Protoceras sandstone zone. In the latter are several thick beds of volcanic ash, and mixtures of ash sand and silty clay, which appear as white bands and a white capping in the view. The pinnacled erosion forms of the upper member are due to their hardness, while the clays below develop long rounded slopes incised by widely flaring gullies. These clays are of pale buff and light gray tints with faint pinkish bands.

Badlands of South Dakota and Nebraska

By N. H. DARTON-Washington.

Tafel 3.

Forms due to beds of sandstone in the sandy clays, Big Badlands, South Dakota.

The Protoceras sandstone member shown in this view consists of deposits of sandstone interbedded in sandy clays. Above it are clays of the Leptauchenia zone, below are the Oreodon beds. The sandstone being hard and the clays much softer great diversity of form is developed as the rapid erosion progresses. The sandstone is variable in thickness and continuity and its hardness also varies greatly from place to place. In general every bed of the sandstone causes a prominent ledge step or cliff in the slopes of the sandy clay and many masses separated by erosion cap columns of various sizes. These caps usually project on all sides beyond the clay column below and in many of the cliffs the softer material washes out from under the sandstone as shown very clearly in the middle of the view. At this place the presence of the hard sandstone layer has caused a fall in the drainage way and water runs rarely over it excepting occasionally for a few hours when there is a rain.

Tafel 4.

Towers in the Protoceras sandstone area, Big Badlands of western South Dakota. Sandy clays with coarse sandstone layers.

The Protoceras sandstone member of the White River group gives rise to great variety of topographic features in the Big Badlands. The sandstone beds are intercalated in light colored sandy clays or soft silty sandstone and erosion carves the harder sandstone into rugged features as compared with the longer slopes and rounded buttresses of the softer rock. Every ledge of the sandstone gives rise to a cliff and as this cliff is cut into by eroding gullies the sandstone fragments are separated and many are left capping columns of the sandy clay. Features of this sort are conspicuous in the view, which shows sandstone-capped columns of various sizes and shapes some of them 40 to 50 feet high. The layer which surmounts most of the columns in this view caps a plateau area of considerable extent and these features are developed around its rugged edges where erosion is in rapid progress. The resistance of the hard rock to erosion is shown by its persistence in the talus where the large fragments accumulate as the clay is washed away.

Badlands of South Dakota and Nebraska

By N. H. DARTON-Washington.

Tafel 5.

One of the central ridges of the Big Badlands of western South Dakota.

This general view southeastward in the center of the Big Badlands was taken from a point on the summit of the irregular ridge separating the drainage of White River from that of South Fork of Cheyenne River. The badland valleys to right and left of the central ridge or spur are affluent to White River, 10 miles distant. The ledges are due to the Protoceras sandstone member consisting of layers of hard, gray sandstone interbedded among the light buff clays. These sandstones mark the course of old channels and accordingly thicken and thin irregularly. On thick mass is seen on the left of the view in the middle distance. The overlying clays in the middle of the view are known as the Leptauchenia zone; owing to their softness they weather in rounded slopes broken by ledges due to layers of concretionary masses. The high butte to the right in middle distance is a remnant of the plain from which the badlands have been eroded. Very little of this plain now remains in the region between White and Cheyenne Rivers. Far to the west it abuts against the middle slopes of the Black Hills as shown in figure 2.

Tafel 6.

Badland erosion in Brule clay in slopes on north side of Scotts Bluff on Platte River, western Nebraska. Shows remnants of original terrace in which badlands have been eroded.

The White River group is extensively exposed by the wide trench excavated by North Platte River in the Great Plains of western Nebraska. In places typical badlands are developed, notably in the steep slopes about Scotts Bluff near Gering about 40 miles southwest of Alliance; see map (figure 1). The view shows details of erosion in the Brule clay with remnants of the plain from which the badlands were eroded. These remnants are covered with grass and are parts of the system of terraces bordering North Platte River which is seen in the middle distance. The badlands present bare surfaces of light cream to flesh-colored clay, or mixtures of clay and sand mostly compact and very homogeneous in texture. A few thin layers of sandstone occur in places and their presence is marked by small ledges breaking the clay slopes. The small valleys which ramify through these badlands are dry, excepting occasionally for a few hours when there is a rainstorm, for the climate is arid with only about 15 inches annual rainfall.

N. H. Darton, Badlands of South Dakota and Nebraska

„Pulpit Rock". Big Badlands, South Dakota

„Kanzelfelsen". Big Badlands, Süd-Dakota

„Roc de la chaire". Mauvaises Terres, Dakota du Sud

N. H. Darton, Badlands of South Dakota and Nebraska

Spur of south end of Sheep Mountain, Big Badlands, western South Dakota

Südsporn des „Schafberges". Big Badlands, Süd-Dakota

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